Conversion Factory

A TOOL TO EVALUATE ALTERNATIVE SUPPLY CHANNELS INVOLVING DIFFERENT PURCHASING COSTS AND DIFFERENT TRANSPORTATION COSTS.

Author: L. Pauliuk; PDEng

Introduction

This report describes a generic tool for evaluating alternative supply structures for multiple site production situations. The tool has been developed based on the solution designed for evaluating two supply scenarios for a Dutch company in the automotive.

Scope

The tool supports strategic decisions regarding the structure of the supply chain for materials needed for production processes at one or more sites of a company. The sites, and the production processes at the sites, are given, as are the materials needed for each production process. Each production site requires materials that are produced by the same set of manufacturers, and each manufacturer operates a distribution system that provides for a local distributor close to each of the production sites.

Statistics are available on the demand per supply period (for instance a day) for each material at each site, over a sufficiently long time (for instance a year).

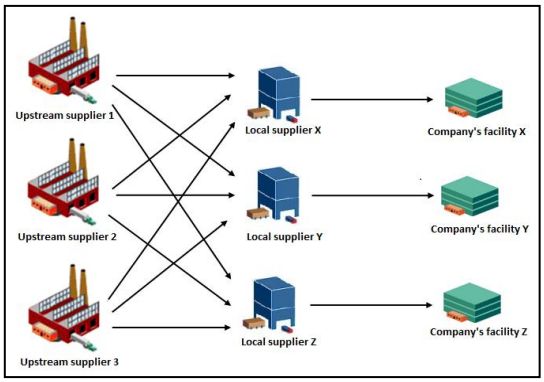

Figure 1: Scenario 1

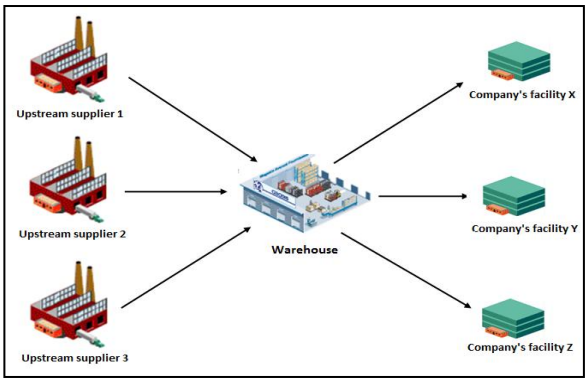

Figure 2: Scenario 2 & 3

Available supply channels and their consequences

For each material, three supply channels are available:

- The first supply channel consists of buying the material from the local distributor, to be delivered within an agreed lead time at the site (Figure 1).
- The second channel consists of buying the material in the quantity needed per period from the upstream manufacturer, to be delivered at a hub of a Logistics Service Provider, cross docked at the hub, and having the material transported to the production sites by the Logistics Service Provider (LSP) (Figure 2).
- The third channel consists of buying the material in an optimal quantity from the upstream manufacturer, to be delivered to and stocked at the warehouse in the hub of an LSP, and having the demand per period picked at and delivered from the hub to the production sites by the LSP (Figure 2).

These scenario's have different consequences.

Regarding distribution structure:

- The first scenario makes full use of the distribution structure of the manufacturer.
- The second scenario makes partial use of the distribution structure of the manufacturer, and uses a logistic service provider for the cross docking at the hub and the transportation to the production sites.
- The third scenario makes also use of stock keeping services of the logistics service provider.

Regarding price and terms:

- In the first scenario, the company can negotiate the price and the terms of delivery with the local distributors near to each site. The price will cover the materials costs for the distributor, the costs of distribution up to the local distributor, the stock keeping costs at the local distributor, and a mark up for profit.
- In the second scenario, the company can negotiate with the manufacturer the price of the materials to be delivered at a hub, and negotiate the price of cross docking and transportation to the production sites with one or more logistics service providers.
- In the third scenario the company also negotiates the costs of materials handling and storing related to the stock keeping with the LSP.

Regarding supply deliveries

In the first scenario supply from different manufactures lead to separate deliveries from the local distributors to each production site.

In the second and third scenario, supply from different manufacturers to each site is consolidated at the hub, and delivered to each production site in one drop.

Conclusion

Clearly, the three scenarios differ in operational processes and costs. The tool enables the user to determine which scenario is the most cost effective, based on volume related purchasing, materials handling, stock keeping, and transportation costs, provided by the local distributors, the manufacturers, and the logistics service provider.

In the system description below, we first describe the scenarios one and two, and for clearness reasons, describe scenario three as a variant of scenario two.

System Description
This paragraph explains in detail how the tool works. A number of different modules are used. Each prepares the data needed for finding the preferable solution.

Module total supply costs for all production sites
The tool takes as an input the past demand for each material at each site per supply period. Demand is dependent demand, that is, demand for materials result from the production planning of end products at the site. Accordingly, the supply period length is given by the planning period used in the production planning.

From these past demand data, statistics are made, giving for each material: the distribution of the demand per supply period for each site.
This is input to the module that estimates the costs of the first scenario. This module contains for each local distributor of each manufacturer, the prices quoted by the local distributor of the materials as a function of volume ordered per supply period and lead time of delivery to the production site. Taking into account the variations in demand per supply period, the module gives the total supply costs for all production sites over the year.

Aggregate and group data to compare 1st and 2nd scenario.
For evaluating the costs of the second scenario, the demand per material per supply period per production site, is first aggregated overall production sites, giving the demand per material per supply period, and next aggregated into demand per manufacturer per period.
This is input to a module that estimates the costs of purchasing the materials at the manufacturer and to be delivered to the hub, based on the prices and discount structures provided by the manufacturers.

Comparing these costs with the costs of the first scenario gives the purchasing costs advantage of the second scenario over the first scenario. Notice that this comparison is done per manufacturer, since each material is delivered by one manufacturer only. So if we group materials according to their manufacturer, the module shows the purchasing costs advantage of buying upstream for the different material groups.

For evaluating the costs of cross docking at the hub, the demand per period per material group is aggregated further into the demand per period. This is input to a module that estimates the cross docking cost, based in the tariffs for cross docking per standard material item provided by the LSP.

For evaluating the transportation costs to the production sites, the demand per material per period per production site is aggregated into demand (expressed in standard items) per period per production site. Together with the locations of the production sites, this is input to a module that calculates the transportation costs, based on tariffs for the distance travelled, the amount of transportation capacity used, the number of stops, and the number of items to be unloaded.

Scenario two is more cost effective than scenario one if the purchasing cost advantage minus the sum of the cross docking costs and the transportation costs is smaller than the costs of scenario one.

Notice however that it is not obvious which material group should be supplied under scenario two or under scenario one.

Which scenario to choose for which material group?
To see this, observe that the evaluation can be done separately for each material group, that is, for each group of materials produced by one manufacturer. This would result in the purchasing costs advantage for each separate manufacturer, clearly showing the differences between manufacturers in this respect, and in the cross docking and transportation costs for each group of materials separately. Comparing purchasing advantage minus costs with the costs of scenario one for each material group separately, might result in a negative result for scenario two for some material groups. However, this approach neglects the economies of scale that can be obtained from combining cross docking and transportation for the different material groups.

Thus, we need to evaluate all possible combinations of using either scenario one or scenario two for each of the product groups.
For a system with N product groups, this results in 2 to the power N different combinations to be evaluated. It is well possible that having some material groups supplied from the local distributors, and all other groups supplied from the manufacturers leads to lower total costs than having all material groups supplied from the manufacturers.
We have developed an exhaustive search procedure that, for problems of limited size, finds the optimal combinations of downstream and upstream buying over the material groups.

The combined ordering of items needed by all production sites on each day allows for the use of quantity discounts offered by the manufacturers.

However, this still limits the discounts to the volumes needed on separate days. Further advantages may be possible by ordering more than the amount needed on one day that is, ordering in advance of demand.

This would imply stock keeping at the hub, additional materials handling costs, and stock keeping costs. As a variant of scenario two, scenario three allows for this possibility.

When to use scenario three?
Under scenario three, the cross docking and picking costs, and the transportation costs from the hub to the production sites, are the same as under scenario two. The only difference is in the purchasing advantage per material group.

For evaluating the purchasing advantage under scenario three, the demand per item per day is aggregated into the demand per item per year. Together with the costs of placing an order, the costs of keeping one item in stock per year, and the purchasing discount as a function of order size, these numbers are input to a module that calculates for each item the optimal purchasing order size. Using this optimal order size per item the module next calculates total purchasing and stock keeping costs per material group per year. This results in its turn in the purchasing costs advantage of scenario three over scenario one, after substraction of the purchasing costs under scenario one.

The optimal combination of supply modes per materials group that minimizes total supply costs can next be determined using the same method developed to optimize supply under scenario two.

System Use / Guideline
Available in the Excel tool